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Pacific Region

Canadian Science Advisory Secretariat
Science Advisory Report 2017/039

IDENTIFICATION OF HABITAT OF SPECIAL IMPORTANCE TO FIN WHALES (*BALAENOPTERA PHYSALUS*) IN CANADIAN PACIFIC WATERS

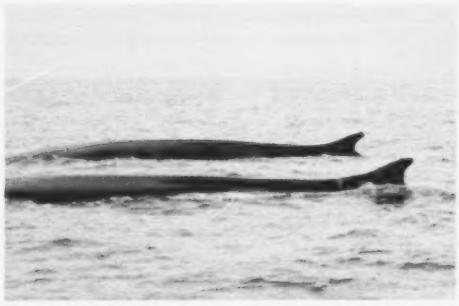

Photo credit: John Ford, DFO

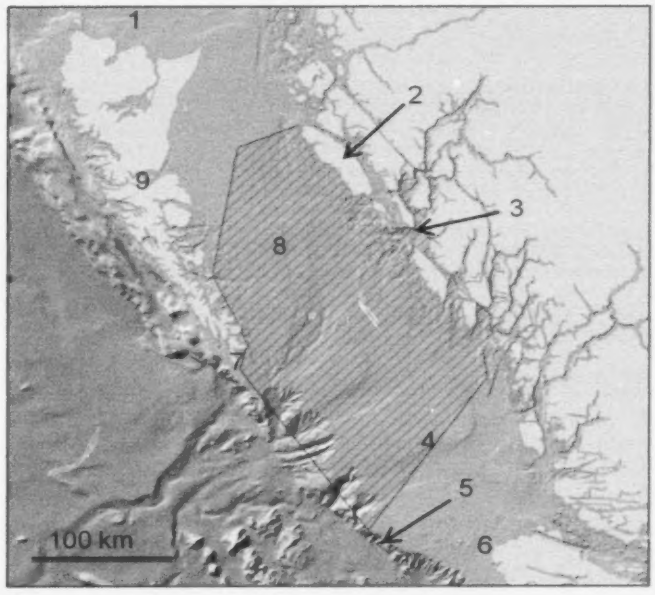

Figure 1. (right). Important habitat (red shading) for fin whales in British Columbia. Places names mentioned in text: 1. Dixon Entrance, 2. Banks Island, 3. Greater Caamaño Sound, 4. Queen Charlotte Sound, 5. continental shelf edge, 6. Cape Scott, 7. Cape St. James, 8. Hecate Strait, 9. Haida Gwaii.

Context:

In 2006, fin whales in the Canadian Pacific were listed as Threatened under Canada's Species at Risk Act (SARA). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended this listing because fin whale sightings are uncommon in British Columbia (BC) as a result of population depletion throughout the North Pacific from commercial whaling (20th century). As required by SARA a Recovery Strategy (2006) and a partial Action Plan (2013) were completed. SARA requires the identification of critical habitat for Threatened or Endangered species. Critical habitat under SARA is defined "as habitat necessary for survival or recovery of a listed wildlife species..." SARA further defines habitat for aquatic species as areas for rearing, food supply, migration or any other areas on which aquatic species depend directly or indirectly to carry out life processes. At the time the Recovery Strategy was prepared, existing information was inadequate to identify critical habitat and a schedule of studies was included in the document as required by SARA to address this issue. An updated schedule of studies was included in the partial Action Plan based on the best available information up to 2011 which indicated information was still insufficient. The Species at Risk Program requested Science advice on information and current knowledge regarding important habitat for fin whales in Canadian Pacific waters.

This Science Advisory Report is from the February 23-26, 2016 National Marine Mammal Peer Review Committee (NMMPRC): Habitat Requirements for Killer Whale (Northeast Pacific northern and southern resident populations), Fin Whale (Pacific), and Blue Whale (Atlantic). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

August 2017

Canada

SUMMARY

- Fin whale populations in the North Pacific were severely depleted as a result of commercial whaling in the 20th century. Whaling catch records (n = 7,605) from BC shore-based whaling stations (1908 to 1967) indicate that most fin whales were killed west of the continental shelf. However, fin whales were also hunted in Hecate Strait, Queen Charlotte Sound, Greater Caamaño Sound and Dixon Entrance.
- Sightings from surveys (2002-2015) indicate that fin whales are encountered off the continental shelf west of Haida Gwaii and Vancouver Island, along the 1000 m isobaths between Cape St James and Cape Scott, but also on the continental shelf in Hecate Strait, Queen Charlotte Sound, Greater Caamaño Sound and Dixon Entrance.
- Geographic variation in fin whale song as well as genetic studies suggests some degree of population structure may exist in the Northeast Pacific. The occurrence of two song types (type 1 and 2), suggest the distribution of at least two population components may overlap BC waters. One component, that produces song type 2, may use coastal waters more often while the other component may be distributed offshore. Only song type 2 has been detected on inshore recorders in BC.
- Although there have been survey efforts in offshore waters of British Columbia most of the effort has occurred in the accessible inshore waters of Hecate Strait and Queen Charlotte Sound and Greater Caamaño Sound. Furthermore, the fin whale satellite telemetry study took place only in Hecate Strait and Greater Caamaño Sound. Consequently, this assessment of important habitat for the fin whale in British Columbia is limited to this inshore region.
- Modelling of sightings and effort from ship surveys (2002-2014) in Hecate Strait and Queen Charlotte Sound revealed an association between fin whale presence and Moresby Trough, a deep-water gully that extends northeast from the shelf break south of Haida Gwaii towards Banks Island on the east side of Hecate Strait. It also showed an association with the heads of submarine canyons near the 1000 m depth contour between Cape Scott and Cape St James, and with areas along the mainland coast, particularly Greater Caamaño Sound.
- The significance of habitat in Hecate Strait and Queen Charlotte Sound is underscored by previous fin whale distribution models that identified similar areas, based on whaling data (1949-1967) and line-transect surveys (2004-2008).
- Based on mark-recapture analysis of photo-identifications, an estimated 405 fin whales (CV =6%, 95% CI: 363-469) were present in Hecate Strait and Queen Charlotte Sound during the photo-identification period of 2009 to 2014. An abundance estimate for the same region, based on line-transect survey data from an earlier time period (2004-2008), yielded a similar estimate (mean: 329; 95% C.I. 274-395).
- There are no fin whale abundance estimates for offshore regions of British Columbia.
- Fin whales tagged in Greater Caamaño Sound and in Hecate Strait remained in the region during the period of their tag transmission. Analyses of whale movement recorded by the tags indicated periods of area-restricted movement, that may represent foraging behaviour, lasted for days or weeks but were interspersed with periods of directed movement indicative of travel within Hecate Strait, Queen Charlotte Sound, and Greater Caamaño Sound.
- Analyses of dive data indicated that in Greater Caamaño Sound, fin whales exhibited a strong consistent diurnal pattern with longer, deeper dives during the day than at night. This

pattern suggested the animals were foraging on diel vertically migrating zooplankton that occur in dense patches at depth during the day.

- Acoustic monitoring revealed that fin whale calling activity in Hecate Strait and Queen Charlotte Sound was greater than in the offshore areas that were monitored (2009 to 2015).
- Timing of peak periods of singing by males at Hecate Strait sites (November to January) was slightly later seasonally than at other sites. This suggests the possibility of a seasonal movement of fin whales into the Hecate Strait and Queen Charlotte Sound in late fall and winter, which would coincide with the breeding season of this species in the North Pacific.
- Details of fin whale catches in the BC historical whaling records indicate that 75% of births would have occurred between mid-November and mid-March, with a peak in January. Combined with high levels of calling, this suggests that courtship and mating, and calving, could be occurring in Hecate Strait and Queen Charlotte Sound.
- Sightings of fin whales with dependent calves (2006 to 2015), indicates that some fin whales also rear young while in Hecate Strait, Queen Charlotte Sound and Greater Caamaño Sound.
- Given the evidence provided above and using the bounding box approach, an area encompassing Greater Caamaño Sound and part of Hecate Strait and Queen Charlotte Sound was identified as important foraging, breeding, mating and rearing habitat for fin whales.
- Important features and attributes of this area include sufficient quantity and quality of prey, sufficient physical space to freely maneuver, water of sufficient quality so as to not result in loss of habitat function, and an acoustic environment that does not interfere with communication, or navigation, or impede use of important habitat by fin whales or their prey.
- Anthropogenic activities that are likely to result in loss of function of this important habitat include those that would result in reduced prey availability or accessibility, acoustic disturbance, environmental contamination, and physical disturbance
- Climate change may also affect habitat functions by altering prey availability and physical properties of the ocean. Anthropogenic activities and their effects on habitat functions need to be managed in the context of this ongoing issue.
- The area identified in this study likely constitutes only part of the habitat in British Columbia important to fin whales. There is a need to expand research efforts into offshore waters to determine the use and importance of offshore habitats by fin whales.

BACKGROUND

The fin whale occurs almost worldwide from polar regions to the equator. A distinct seasonal migration between high-latitude summer feeding grounds and low-latitude breeding grounds, a characteristic of many baleen whale species, is not apparent in fin whale populations in the North Pacific. Fin whales are distributed in both offshore and inshore coastal regions. In the North Pacific, fin whales are often found relatively close to shore, and regularly enter deep sounds and inlets.

Fin whale populations in the North Pacific were severely depleted as a result of commercial whaling in the 20th century. Whaling reduced the number of fin whales in the North Pacific to an estimated 13,000 – 19,000 by 1973, of which 8,500 – 11,000 were assumed to be from the eastern North Pacific. Whaling records suggest fin whales in BC were historically distributed mostly offshore, but animals were also distributed in Hecate Strait and Queen Charlotte Sound

including the confined waterways of Greater Caamaño Sound. Most fin whales killed in BC during 1948-1967 were caught in depths of 1800-1900 m, although animals were also hunted in inshore regions where depths were less than 1000 m.

Studies of fin whale life history indicate that they reach sexual maturity at 5 to 15 years, and attain lengths of 17.8 and 19.8m, in males and females respectively, in the North Pacific. The life span of a fin whale is thought be about 80 years. The calving interval is two years and females give birth after an 11-12 month gestation period. Calves are approximately 6 m in length at birth, and are weaned at approximately 11.5 m.

Fin whales are large-bodied filter-feeding grazers that prey on dense aggregations of tiny prey organisms including zooplankton and schooling fish that they obtain by lunging feeding at depth and near the surface. The only direct diet data available in BC comes from historical whaling records from Coal Harbour. Of 959 fin whales killed and examined in the years 1955 to 1967, euphausiids were present in the stomachs of 96% of the whales, and copepods in the remaining 4% of the whales. Squid and fish were also present, but in less than 1% of the whales sampled.

ANALYSIS

Distribution in British Columbia

Fin whales occur in Hecate Strait, Queen Charlotte Sound, Greater Caamaño Sound, and Dixon Entrance, along the 1000 m continental shelf edge between Cape St James and Cape Scott, and also seaward of the continental shelf break west of Haida Gwaii and Vancouver Island. This distribution is based upon data from 42 ship surveys (2002 - 2014), photo-identification studies (2002 - 2015), 34 aerial surveys (2012-2015), and historical whaling records (1908-1967). Most of the historical whale catch was taken seaward of the continental shelf, but fin whales were also killed in Hecate Strait, and in particular, in Greater Caamaño Sound. In contrast to the historical distribution of whaling effort, most of the recent study efforts, including ship surveys and photo-identification studies, have taken place in the region of Hecate Strait, Queen Charlotte Sound, and Greater Caamaño Sound. A satellite telemetry study of fin whale movements has been limited to Hecate Strait and Greater Caamaño Sound areas. Therefore the information relevant to the assessment of important habitat is restricted to this inshore region for this assessment.

Modelling of sightings and effort from ship surveys (2002-2014) in Hecate Strait, Queen Charlotte Sound and Greater Caamaño Sound revealed an association between fin whales and Moresby Trough, a deep-water gully that extends northeast from the shelf break south of Haida Gwaii to Banks Island. It also illustrated an association with the heads of submarine canyons near the 1000 m depth contour between Cape Scott and Cape St. James, and with areas along the mainland coast, particularly Greater Caamaño Sound (Figure 2). The predicted distribution of fin whales from this model compares well with the spatial predictions of three previously published models that include this area; one based on historical whaling data (1948-1967) (Gregr and Trites 2001), the others based on line transect survey data (2004 to 2008) (Williams and O'Hara 2009; Best *et al.* 2015).

Seasonal distribution

In BC waters, fin whales were sighted in all seasons during ship and aerial surveys. This is consistent with other published reports indicating a year-round occurrence of this species at high latitudes in the North Pacific. Analysis of acoustic data from remote monitoring sites in BC has demonstrated that fin whale songs, produced by males and associated with mating, are detected throughout fall and winter months in BC and provide further confirmation that fin

whales are present year-round. The presence of calling males also suggests that breeding occurs in Canadian Pacific waters.

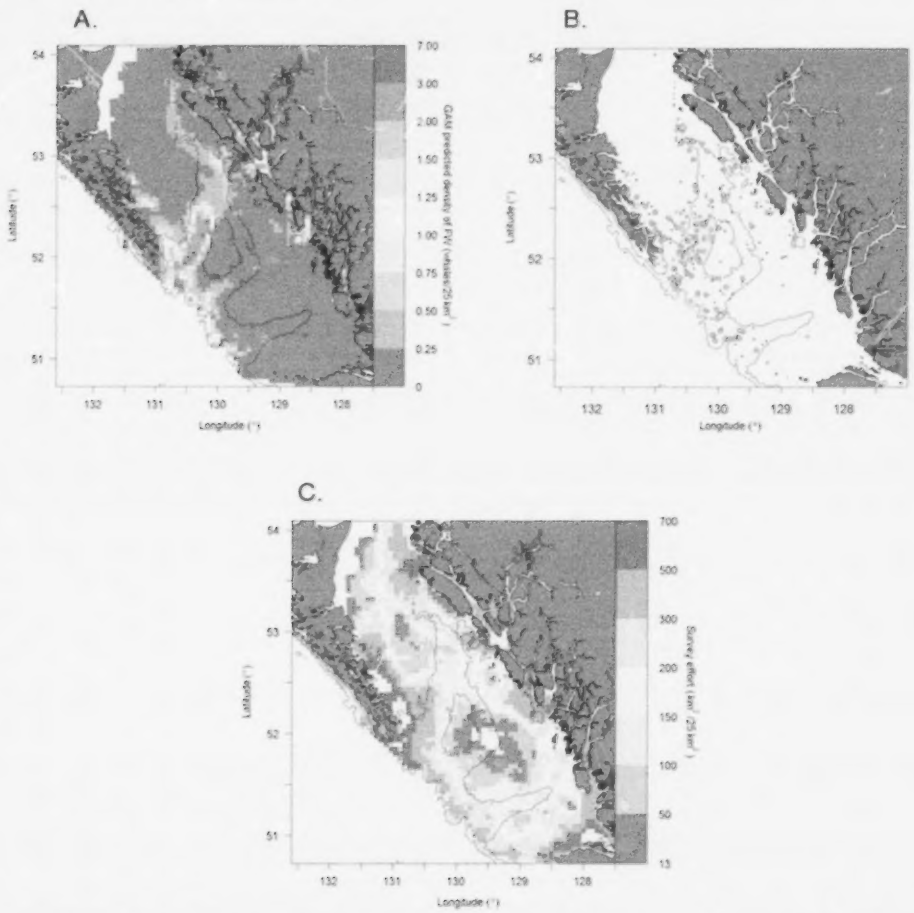

Figure 2. Fin whale distribution in Hecate Strait, Queen Charlotte Sound and Greater Caamaño Sound. A. Model predicted distribution as a function of latitude slope, depth, and B. Fin whale sightings from 37 surveys used in the model (2002-2014), C. Survey effort expressed as km^2 of effort per 25 km^2 grid cell (2002-2014).

Acoustic monitoring sites in Hecate Strait and Queen Charlotte Sound had the most frequent and sustained acoustic activity of all sites in BC analyzed (Figure 3). Peak periods of song (November to January) were offset seasonally from peak periods of singing at all other sites suggesting a seasonal movement of fin whales into Hecate Strait and Queen Charlotte Sound in late fall and winter, coinciding with the climax of the breeding season. Details of fin Whale kills in the BC historical whaling records indicates that 75% of births would have occurred between mid-November and mid-March with a peak in January. These data combined with high levels of calling and the offset peak of calling activity from everywhere else in this study region suggest that courtship and mating, and possibly calving, occur in Hecate Strait and Queen Charlotte Sound.

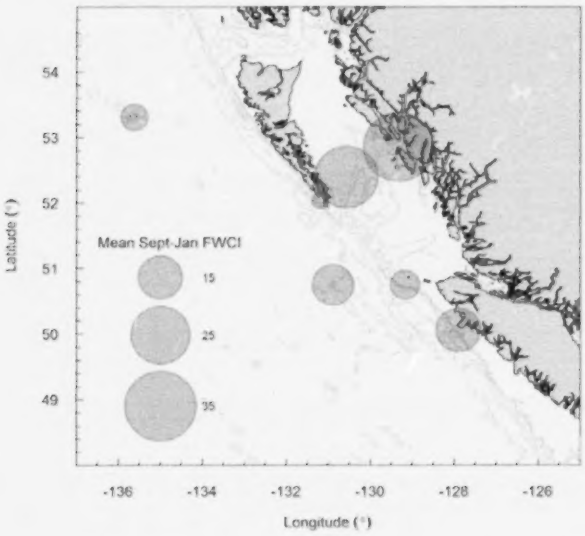

Figure 3. Map showing autonomous acoustic recorder locations. Size of red circles is proportional to the mean daily call index values between September 1st and January 31st (2009-2015), corrected for area-transmission loss.

Abundance

To estimate abundance of fin whales in Hecate Strait, Queen Charlotte Sound, and Greater Caamaño Sound, photo-identification data of 283 whales (2009-2014) were analysed using mark-recapture techniques. A total of 405 fin whales (CV =6 %, 95% CI: 363-469) were estimated, representing the number of animals present in the area at any time during the period 2009 to 2014 regardless of whether they were all present at a given time. A line transect survey based estimate for the same region (but including Dixon Entrance) reported 329 animals (95% CI: 274-395) present in the study area at any time during the survey years (2004 -2008) (Best et al. 2015).

There are no historical abundance estimates but catch records reveal that in a 15-year period (1952-1966), 240 fin whales were killed in Hecate Strait and Queen Charlotte Sound (152 males, 88 females). Of this total, 47 were killed in the confined waterways of Greater Caamaño Sound, demonstrating the historical use of this habitat by fin whales.

Behaviour and movements inferred from satellite-linked tags

Fin whales tagged in Hecate Strait and Greater Caamaño Sound (2011-2014) undertook directional movements interspersed with periods of area-restricted movements for days or weeks at a time. Areas where animals exhibited area-restricted movement included Greater Caamaño Sound, Moresby Trough, and along the mainland side of Hecate Strait off Banks Island. Periods of area-restricted movement are inferred to represent foraging but could also represent other non-directional behaviours such as social behaviour. All of the tagged animals remained in Greater Caamaño Sound or Hecate Strait for the duration of their tag's transmission, (mean tag transmission duration = 27.6 days (range = 8.1- 60.2 days, n = 19 tags).

Dive profiles of tagged animals, during periods when they exhibited area-restricted movement, illustrated a significant diurnal pattern to their dives in Greater Caamaño Sound. Dives were longer and deeper during day-light hours than at night. The strong diurnal pattern suggests Greater Caamaño Sound is an important feeding area and that fin whales may be targeting aggregations of vertically migrating zooplankton that occur in dense layers at depth during the day.

Movement and site fidelity

Analysis of photo-identification data provided insight into movements of fin whales in BC waters (1995-2015). Although there is less photo-identification effort offshore compared to the inshore region, there is little photo-identification evidence of fin whales moving back and forth between inshore (Hecate Strait, Queen Charlotte Sound, and Greater Caamaño Sound) and offshore (seaward of the continental shelf) areas. Although greater photo-Identification effort inshore compared to offshore may, at least in part, drive this result, there may be real population differences between the inshore and the offshore. Genetics analysis and geographic variation in fin whale song indicate that population structuring may exist in the Northeast Pacific. Analysis of acoustic data from autonomous recorders deployed off the BC coast has revealed two song types. Fin whales that produced song Type 2 were detected throughout coastal British Columbia, in coastal inlets and along the shelf edge, but also offshore at Bowie Seamount. In contrast the Type 1 song was heard only offshore. Further study, including increased photo-identification effort in the offshore region, is needed.

Significance of Hecate Strait, Queen Charlotte Sound and Greater Caamaño Sound

Our analyses indicate that the region encompassing Hecate Strait and Queen Charlotte Sound, and Greater Caamaño Sound is occupied year-round by fin whales, and at times in large aggregations. Fin whales forage, but also potentially breed and rear young, in the region. Tagged fin whales travelled back and forth across Hecate Strait, particularly following the long axis of Moresby Trough. Satellite-linked tagged data, coupled with photo-identification data, in Greater Caamaño Sound suggested that animals were focused on foraging and that individuals have fidelity to this area based on resightings of known individuals in multiple years. Based upon the number of whales killed in the areas, Hecate Strait, Queen Charlotte Sound and Greater Caamaño Sound were also important for fin whales historically. Whaling catches for the period 1952-1966 show that both males and females were present in the area. Observations of females with calves during ship surveys, and the increase in calling activity that occurs November to January suggest that mating and rearing may take place in this area as well. Acoustic analyses suggest there may be a movement of fin whales into the region in winter that could account for the increased calling activity detected on acoustic recorders in Hecate Strait.

Habitat necessary to meet recovery objectives

Given the evidence provided above, using the bounding box approach, an area encompassing Hecate Strait, Queen Charlotte Sound and Greater Caamaño Sound was identified as important fin whale foraging/feeding, as well as possible courtship/mating and calving habitat.

A map showing the boundaries of this important habitat area in Hecate Strait and Queen Charlotte Sound and Greater Caamaño Sound is provided in Figure 1. The area identified has been shown to be occupied for much of the year by high densities of fin whales and is important for feeding and other life processes. This area should be considered as habitat of special importance to fin whales. Note that Dixon Entrance is not included in this area as it is separated from the bounded area by a shallow area which forms a natural boundary. The natural boundary

may explain why there were few photo-identification matches and no satellite tagged animal movement between Dixon Entrance and the bounded area.

The basis for identifying this habitat was the availability of multiple lines of evidence from several field studies. However, because comparable field studies have not yet been completed in offshore regions of Canadian Pacific waters or Dixon Entrance, it is possible that other areas may also be of special importance and be required to achieve the population and distribution objectives outlined in the Recovery Strategy for the entire population. Expanded research efforts into offshore waters will be necessary to determine the use and importance of offshore habitats.

Biophysical functions, features and attributes of important habitat

The habitat identified as important to fin whales serve various functions, including feeding/foraging, socializing, and likely breeding/calving and rearing as described in the Analysis section above. The features and attributes associated with each of these functions are listed in Table 1.

Important features and attributes of this area include sufficient quantity and quality of prey, water quality of a sufficient level so as not to result in loss of function, sufficient physical space to freely maneuver, an acoustic environment that does not interfere with communication related to courtship, mating and calving, or navigation.

Table 1. Biophysical functions, features, attributes of habitat considered important for survival and recovery of fin Whales in Canadian Pacific waters.

Function	Feature(s)	Attribute(s)
Feeding/Foraging Rearing Courtship/mating	Prey Features contributing to prey aggregations and primary productivity, such as spatiotemporal variability of water circulation, including surface currents, topography and prey swimming behaviour	Prey densities and quality to support efficient foraging, life cycle and population growth.
Feeding/Foraging Rearing Courtship/mating	Acoustic environment	Ambient noise levels below a level that would impede communication associated with courtship/mating and rearing, foraging
Feeding/Foraging Rearing Courtship/mating	Physical space	Enough space to maneuver in vertical and horizontal planes, and not alter normal behaviour at and below the surface
Feeding/Foraging Rearing Courtship/mating	Water column	Water quality of a sufficient level to support identified function and to support sufficient prey densities.

Anthropogenic activities likely to destroy important habitat

Activities that are likely to result in the destruction of functions, features and attributes of important habitat are identified in Table 2 and include those that would result in prey reduction, acoustic disturbance, environmental contamination, and physical disturbance.

Sources of uncertainty

Most field research effort has occurred in the inshore region; consequently, less is understood about fin whale habitat use and importance in the offshore region. Therefore the relative

importance of the inshore area identified in this assessment to other areas used by fin whales in Canadian Pacific waters is not known.

Evidence of fin whale vocal activity recorded on autonomous recorders and biological data found in historical whaling records are the basis for suggesting that courtship, mating and calving are functions of the identified important habitat. Further studies, however, including winter field surveys, are needed to refine the details of this function.

The potential existence of two or more distinct population components needs further study using genetic techniques, photo-identification studies, and acoustic monitoring. The existence of multiple population components would have implications for the significance of important habitats.

CONCLUSIONS AND ADVICE

The bounded box in Hecate Strait and Queen Charlotte Sound is expected to capture the majority of the inshore region occupied by foraging fin whales, including areas that may be important for mating and rearing. The bounded box area was identified based on a synthesis of best available information from several quantitative analyses, as well as integration of other published data and historical sources.

It should be noted, however, that the region in the bounded box constitutes partial important habitat to meet population recovery objectives for fin whales in Canadian Pacific waters. It does not include habitats that may exist in the outer region which, based on photo-Identification studies and analyses of song structure, are likely occupied by whales that do not frequent the inner coast region.

Insufficient information was available to assess Dixon Entrance, the inner region waters off the west coast of Vancouver Island, and offshore regions.

There is a need to expand research efforts particularly into offshore waters. Such research will be needed to identify additional areas of important habitat and to refine our understanding of biophysical features and habitat attributes to fully meet the recovery objectives for this species.

Table 2. Anthropogenic activities likely to destroy the functions, features and attributes of important habitat for fin whales in Canadian Pacific waters.

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Acoustic disturbance	Shipping and cruise ships Seismic surveys, military and commercial sonars Pile driving, underwater explosions	Acoustic disturbance resulting in disruption of behaviour or displacement from habitat Acoustic disturbance resulting in loss of habitat availability or function	Feeding and foraging Rearing Courtship/mating	Acoustic environment	Ambient noise levels below a level that would impede communication associated with courtship/mating and rearing, foraging
Release of environmental contaminants	Transportation by vessel of deleterious substances (e.g. petroleum, other contaminants)	Displacement or avoidance of habitat, resulting in reduced foraging efficiency Loss of water quality in habitat resulting in a decrease in foraging opportunities	Feeding and foraging Rearing Courtship/mating	Prey Water column	Prey densities and quality to support efficient foraging, life cycle and population growth Water quality of a sufficient level to support identified function and to support sufficient prey densities.
Physical Disturbance	Vessel traffic in close proximity to whales	Reduction of physical space available to whales	Feeding and foraging Rearing Courtship/mating	Physical space	Enough space to maneuver in vertical and horizontal planes, and not alter normal behaviour at and below the surface

SOURCES OF INFORMATION

This Science Advisory Report is from the February 23-26, 2016 National Marine Mammal Peer Review Committee (NMMPRC): Part II. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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Gregr, E. J. and A. W. Trites. 2001. Predictions of critical habitat for five whale species in the waters of coastal British Columbia. Canadian Journal of Fisheries and Aquatic Sciences **58**:1265-1285.

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